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AUTHOR Hummel, Thomas J.
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ABSTRACT

This paper provides an overview of a prototype simulation-centered intelligent computer-based training (CBT) system--implemented using expert system technology--which provides: (1) an environment in which trainees can learn and practice complex skills; (2) a computer-based coach or mentor to critique performance, suggest improvements, and provide a role model; and (3) a help facility accessible from within the simulation to teach concepts and prescriptions using traditional CBT to deliver content and evaluate mastery. The first section describes the system, which was written in Turbo Prolog and runs on IBM PC compatible computers, noting that it incorporates two databases--one to capture the expert performance information required by the "coach," and the other for the simulation itself. A description of a user interaction with the system is then given which highlights the use of the program's "situation" and "response" windows and its menu system. It is noted that while the prototype demonstrated the feasibility and utility of this approach to interactive computer simulations, it also underscored the difficulties involved in accessing the kinds of rules required to structure knowledge bases in most fields and in working with two interacting knowledge bases rather than one. Future steps which are noted include measures to address these difficulties and to develop a graphics-based user interface. Diagrams of a sample help menu and of situation and response windows are provided. (GL)

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Coached, Interactive Computer Simulations: A New Technology for Training

By

Thomas J. Hummel
University of Minnesota

A Paper Presented at the Annual Meeting of the
American Educational Research Association
Boston, Massachusetts
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Background

This project grew out of a partnership between a large training technology company and a software developer interested in the application of important advances in technology to the development of new approaches to computer based training (CBT).

Most current CBT is designed to capture or reproduce on a computer the methods of traditional instruction, including lecture, textbooks, illustrations, and examinations. Screens of text are presented with supporting graphics and questions are asked to verify student mastery of the material. In this context, simple simulations have been used to provide some opportunity for skills practice.

Professionals learning complex skills, however, require complex environments in which to practice and receive feedback on their performance. Law students participate in moot court, medical students dissect animals or human cadavars, pilots "fly" in complicated electromechanical flight simulators, while others practice interpersonal skills through roleplays. In these conventional skills practice situations, learners receive feedback not only from the consequences of their actions, but also directly from a live instructor who plays a critical role in providing context relevant feedback on performance. In this coaching mode, the instructor provides performance guidelines, models effective performance, and sometimes explains the reasons for choosing particular actions and strategies.

A New Direction

Current computer technology makes it possible to create a new generation of training programs that would provide computer-based analogs to the above types of practice environments. Learners could be placed in complex simulation environments that allow them to select among an almost endless variety of responses to the situation unfolding on the screen. Feedback would be provided by the consequences of the choices being made in the simulation, such as a witness' reply to a question during cross-examination, or the change in a plane's altitude that results from using the controls.

Advances in artificial intelligence make it possible to develop a built-in expert coaching function that would have the ability to provide role modeling, feedback and explanation. Learners could choose which level of coaching they require at any given time, ranging from none to complete demonstration of performance on the task with full explanations for the actions and strategies being selected.

This paper provides an overview of a system designed as a first step toward implementing this new direction. A working prototype is described along with what has been learned from its initial use.

Objective

The specific objective of the project was to design and develop a prototype for the training program described above. Specifically, it would present an example of simulation-centered, intelligent CBT, implemented by using expert system technology, a

programming methodology within the field of artificial intelligence.

Specifically, the program would:

1) Provide an environment in which trainees can learn and practice complex skills.

2) Provide a computer-based coach or mentor to critique performance, suggest improvements and provide a role model. This "coach" would have the ability to take over the simulation, demonstrate skilled performance and explain the reasons for its actions.

3) Provide a help facility, accessible from within the simulation, to teach concepts and prescriptions using traditional CBT to deliver content and evaluate content mastery.

The Program

The prototype was written using Turbo Prolog and runs on IBM PC compatible computers. Rule-based expert system technology was chosen to provide a natural way to implement the coaching function. It also provided the flexibility required for building a shell suitable for developing simulations. The system requires the development of two knowledge bases, one to capture the expert performance information required by the "coach," and the other for the simulation itself.

The prototype presents the user with a menu driven, text-based interface for creating English sentences. These sentences are processed by the simulation and a response is made. The coaching function allows the user to receive a critique and suggestions at any point during the simulation. The user may also request the "coach" to take over the simulation. In this

case, the system constructs the input and, if requested, provides an explanation of its action.

For convenience, the knowledge base used to test the prototype reflects subject matter in an area of the program developer's expertise, research methodology, with the "coach-in-the-box" representing an expert consultant on research design. The next several paragraphs describe interaction with the program based on an interview between the user (a research consultant) and a simulated client and the "coach."

The two primary windows displayed are the "SITUATION" and "RESPONSE" windows. In Figure 1, the SITUATION window contains a statement made by the research consultant's client concerning the topic of the research. The RESPONSE window displays the consultant's response, constructed by making selections from the menus in the lower portion of the RESPONSE window.

The menu system is designed to allow sentences of almost unlimited complexity and length. The menu in which the current selection is being made is displayed in its full width, as is the menu which follows it, with the next menu depending on the selection. The menus, therefore, form a tree structure, rather than a simple fixed sequence. To save space, the menus are overlapped as selections are made, and if necessary, they are eventually "popped" off the left side of the screen.

The user can receive help by pressing the "F1" function key. The "Help Menu" is then displayed, as in Figure 2. The "(Hot!)" designation following some items indicates that those selections may be made directly from the simulation without first accessing

the Help Menu. The user can request feedback and suggestions or ask the built-in coach to take over the simulation.

If "F8" were chosen, "Have coach run simulation with explanation given for actions," the screen would first appear as in Figure 3, where the coach gives its assessment of the situation. Figure 4 shows the next part of the coaching where the strategy is identified, and a "More Detail" window has been opened by the user to obtain more specific information. Finally, the coach uses the menu system to construct a response to the client (See Figure 5). The user can let the coach continue or select a function key which hands control back to the user.

It must be emphasized that information displayed by the simulated client and coach are part of the knowledge base. The small size of the present knowledge base, developed to test the program, limits the program's output at present.

Due to time limitations, functions F2, F3, and F9 on the help menu (See Figure 2) have not yet been implemented in the prototype. With regard to the objectives of this development effort, these functions were deemed the least important and the easiest to implement at a later date. With these exceptions, the computer program embodies all the technical solutions necessary to accomplish the above stated objectives. In this respect, it is important to emphasize that a fully functioning program has been developed, not merely a "slide show" which demonstrates the screens a user would see.

Findings

The prototype demonstrated the feasibility and utility of this approach. At the same time, we learned (again) that it is difficult to access the kinds of rules required to structure a knowledge base in most fields, due to the fact that knowledge generally is not articulated in that form and people with expertise are usually unable to construct such rules easily.

We also discovered, predictably, that it is much more difficult to work with two knowledge bases than with one, as is the case with a straightforward expert system. The complexity of structure is greatly increased by the requirement that the two knowledge bases interact.

Next Steps

The difficulties referred to above highlight the importance of creating an efficient development environment that will make it possible to simplify and speed up the process of capturing information and constructing knowledge bases. Work is currently underway on at least one prerequisite technology for capturing expertise and working with a large amount of complex information.

It is also possible that as such programs become more common, people will become more familiar with their requirements and begin to think about and present knowledge in ways that make it easier to structure in the form of rules.

Another important step will be to move in the direction of developing a graphics based user interface, that will greatly expand the potential for visual representation of the simulation and allow the use of alternative input devices, such as a mouse.

The development of new animation techniques and improved sound synthesizers, along with the increasing availability of interactive 3D graphics, points toward almost unlimited ability to represent even the most complex environments without resort to more costly video strategies.

It will truly challenge the training community to utilize effectively both current and future technology. Knowing that a powerful interactive 3D workstation can currently be purchased for under $30,000 and recalling the aphorism that every two years computing power doubles and its price halves, one can anticipate that "the future" may call on us earlier than we expect.

Figure 1. SITUATION and RESPONSE Windows.

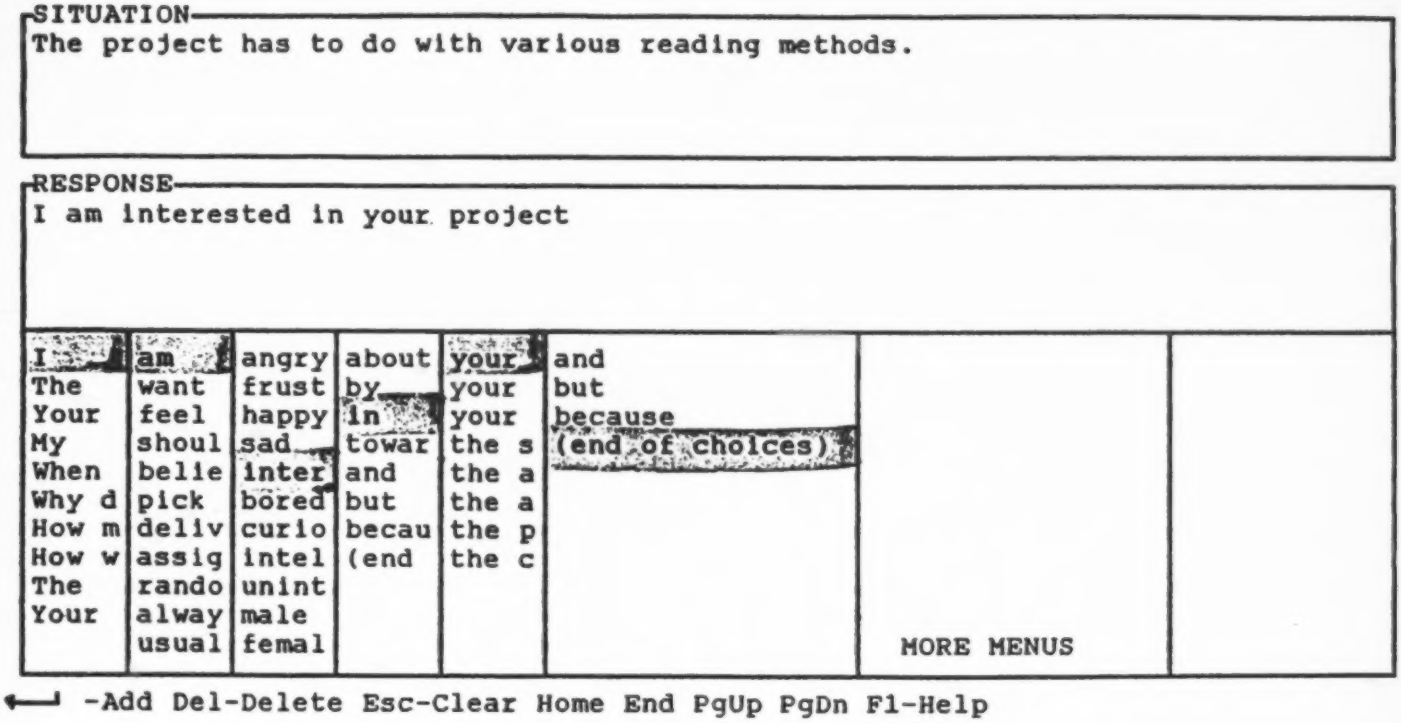

SITUATION
The project has to do with various reading methods.
RESPONSE
I am interested in your project
I am angry about your and
The want frust by your but
Your feel happy in your because
My shoul sad towar the s (end of choices)
When belie inter and the a
Why d pick bored but the a
How m deliv curio becau the p
How w assig intel (end the c
The rando unint
Your alway male
usual femal
MORE MENUS
←┘ -Add Del-Delete Esc-Clear Home End PgUp PgDn F1-Help

Figure 2. Help Menu.

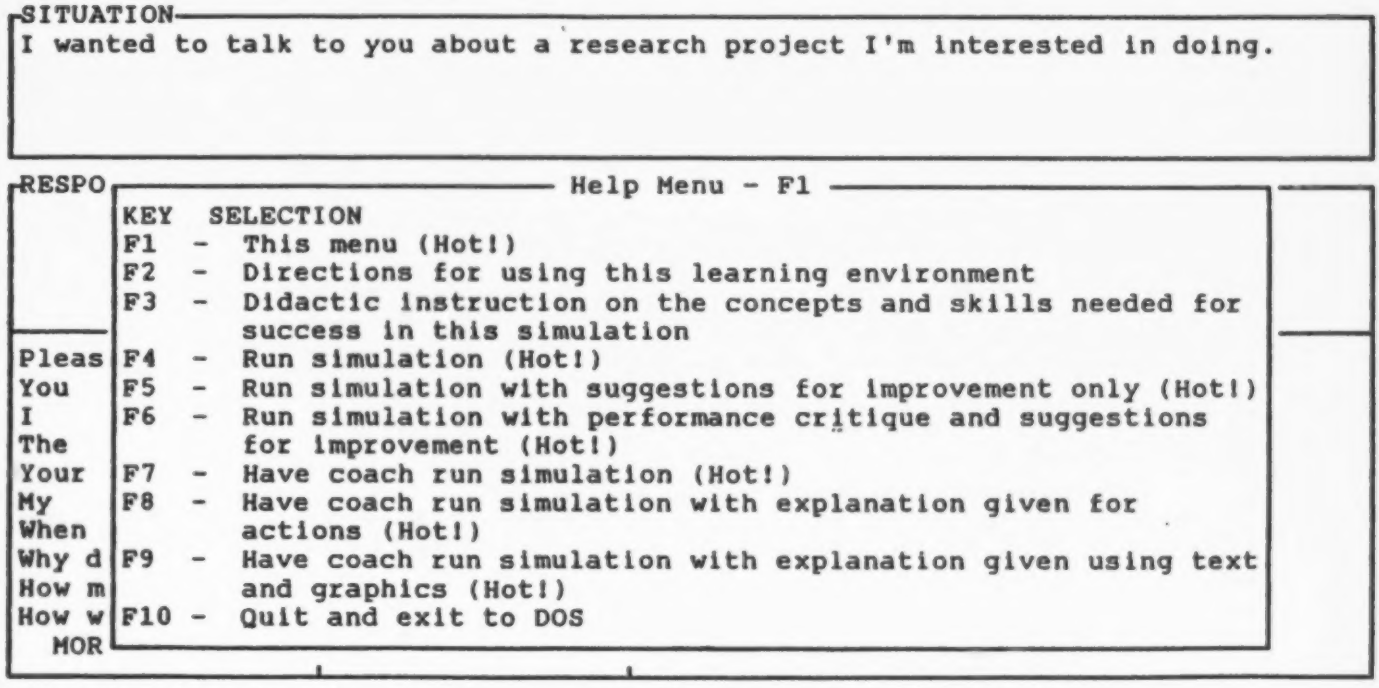

SITUATION
I wanted to talk to you about a research project I'm interested in doing.
RESPO
Help Menu - F1
KEY SELECTION
F1 - This menu (Hot!)
F2 - Directions for using this learning environment
F3 - Didactic instruction on the concepts and skills needed for success in this simulation
F4 - Run simulation (Hot!)
F5 - Run simulation with suggestions for improvement only (Hot!)
F6 - Run simulation with performance critique and suggestions for improvement (Hot!)
F7 - Have coach run simulation (Hot!)
F8 - Have coach run simulation with explanation given for actions (Hot!)
F9 - Have coach run simulation with explanation given using text and graphics (Hot!)
F10 - Quit and exit to DOS
Pleas
You
I
The
Your
My
When
Why d
How m
How w
MOR
Use a function key to select or press the space bar to continue

Figure 3. Simulated Coach's Assessment of Overall Situation Window.

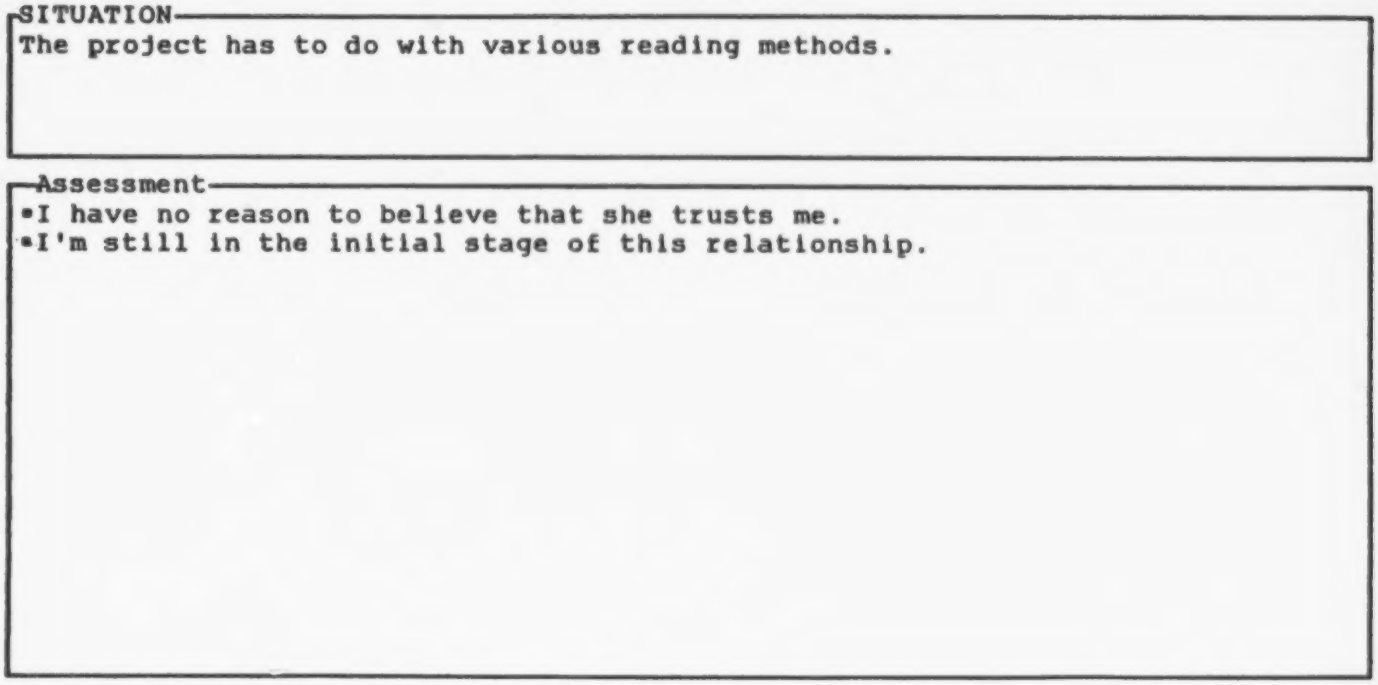

SITUATION
The project has to do with various reading methods.
Assessment
•I have no reason to believe that she trusts me.
•I'm still in the initial stage of this relationship.
Press space bar to continue

Figure 4. Simulated Coach's Strategy and More Detail Windows.

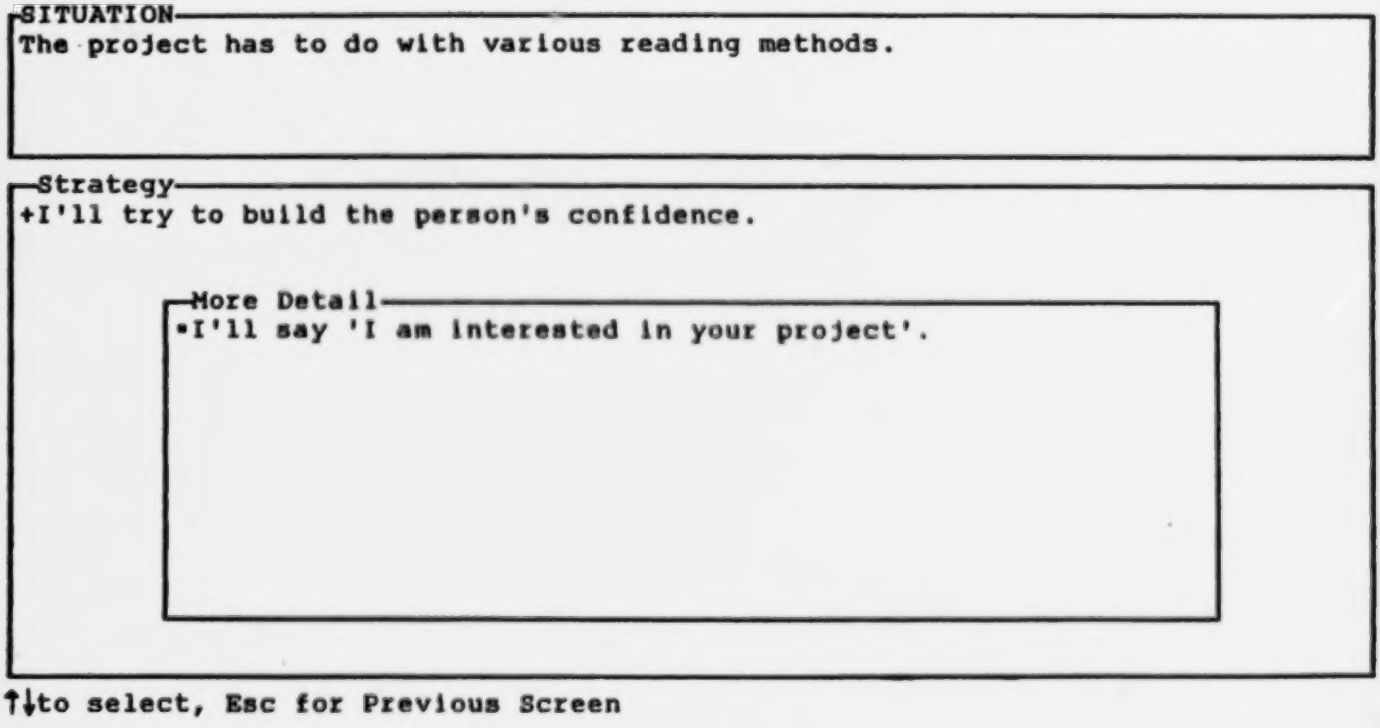
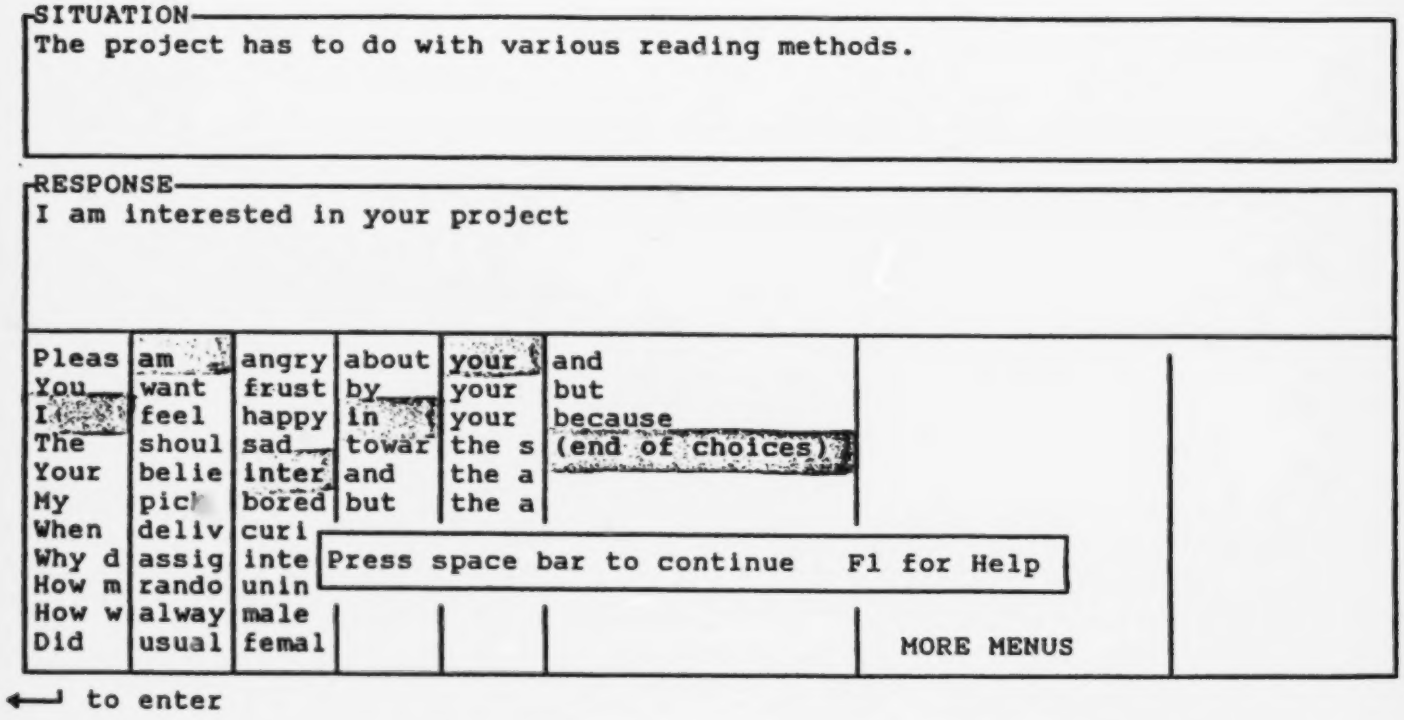

SITUATION
The project has to do with various reading methods.
Strategy
+I'll try to build the person's confidence.
More Detail
•I'll say 'I am interested in your project'.
↑↓to select, Esc for Previous Screen

Figure 5. RESPONSE Window After Simulated Coach Has Finished Responding.


SITUATION
The project has to do with various reading methods.
RESPONSE
I am interested in your project
Pleas am angry about your and
You want frust by your but
I feel happy in your because
The shoul sad towar the s (end of choices)
Your belie inter and the a
My pick bored but the a
When deliv curi
Why d assig inte
How m rando unin
How w alway male
Did usual femal
Press space bar to continue F1 for Help
MORE MENUS
to enter